CLAIMS

What is claimed is:

1. A composition having an empirical formula

$$Li_{x1}A_{x2}Ni_{1-y-z}Co_yB_zO_a,$$

wherein:

- x1 is greater than about 0.1 and equal to or less than about 1.3,
- x2 is greater than about 0.0 and equal to or less than about 0.2,
- y is greater than about 0.0 and equal to or less than about 0.2,
- z is greater than about 0.0 and equal to or less than about 0.2,
- a is greater than about 1.5 and less than about 2.1,
- A is at least one element selected from the group consisting of barium, magnesium, calcium and strontium, and
- B is at least one element selected from the group consisting of boron, aluminum, gallium, manganese, titanium, vanadium and zirconium.

2. The composition of Claim 1, wherein B is at least one element selected from the group consisting of boron, aluminum, gallium and manganese.

3. The composition of Claim 2, wherein A is magnesium.

4. The composition of Claim 3, where B is manganese.

5. A method of forming a composition, comprising the steps of:

Express Mail Label No. EV 760 295 967

a) combining lithium, nickel, cobalt, at least one element A selected from the group consisting of barium, magnesium, calcium and strontium, and at least one element B selected from the group consisting of boron, aluminum, gallium, manganese, titanium, vanadium and zirconium, in the presence of oxygen, in a relative ratio of $Li_{x1}:A_{x2}:Ni_{1-y-z}:Co_y:B_z$, wherein: x1 is greater than about 0.1 and equal to or less than about 1.3,

x2 is greater than about 0.0 and equal to or less than about 0.2, and

y is greater than about 0.0 equal to or less than about 0.2,

z is greater than about 0.0 and equal to or less than about 0.2; and

b) heating the combination to a crystallization temperature in a range of between about 400°C and about 950°C for a period of time that causes the elements to form a crystal structure.

6. The method of Claim 5, wherein the combination is heated to the crystallization temperature in an oxidizing atmosphere.

7. The method of Claim 6, wherein the oxidizing atmosphere includes at least one element selected from the group consisting of O_2, CO_2, and NO_2.

8. The method of Claim 5, wherein the combination is heated to the crystallization temperature in an inert atmosphere.

9. The method of Claim 8, wherein the inert atmosphere includes at least one element selected from the group consisting of nitrogen and argon.

10. The method of Claim 5, wherein the combination is heated to the crystallization temperature in an atmosphere at an absolute pressure in a range of between about 0.5 atm and about 2 atm.

11. The method of Claim 5, wherein the combination is heated to the crystallization temperature by ramping up the temperature of the combination at a rate in a range of between about 5°C per minute and about 10°C per minute.

12. The method of Claim 11, wherein the combination is held at a first crystallization temperature in a range of between about 300°C and about 500°C for a period of time in a range of between about 0.5 and about 4 hours.

13. The method of Claim 12, wherein the combination subsequently is heated at a rate in a range of between about 5°C per minute and about 10°C per minute to a second crystallization temperature in a range of between about 600°C and about 950°C, at which second crystallization temperature the combination is held for a period of time in a range of between about 0.5 hours and about 24 hours.

14. A lithium battery, comprising a cathode that includes a composition having an empirical formula

$$Li_{x1}A_{x2}Ni_{1-y-z}Co_yB_zO_a,$$

wherein:
- x1 is greater than about 0.1 and equal to or less than about 1.3,
- x2 is greater than about 0.0 and equal to or less than about 0.2,
- y is greater than about 0.0 and equal to or less than about 0.2,
- z is greater than about 0.0 and equal to or less than about 0.2,
- a is greater than about 1.5 and less than about 2.1,
- A is at least one element selected from the group consisting of barium, magnesium, calcium and strontium, and
- B is at least one element selected from the group consisting of

boron, aluminum, gallium, manganese, titanium, vanadium and zirconium.

15. A cathode, comprising a composition having an empirical formula

$Li_{x1}A_{x2}Ni_{1-y-z}Co_yB_zO_a$,

wherein: x1 is greater than about 0.1 and equal to or less than about 1.3,
x2 is greater than about 0.0 and equal to or less than about 0.2,
y is greater than about 0.0 and equal to or less than about 0.2,
z is greater than about 0.0 and equal to or less than about 0.2,
a is greater than about 1.5 and less than about 2.1,
A is at least one element selected from the group consisting of barium, magnesium, calcium and strontium, and
B is at least one element selected from the group consisting of boron, aluminum, gallium, manganese, titanium, vanadium and zirconium.

16. The cathode of Claim 15, where A is magnesium and B is manganese.

17. The cathode of Claim 15, further including a polymeric binder.

18. The cathode of Claim 16, wherein the polymeric binder is selected from the group consisting of polytetrafluoroethylene, polyvinylidene fluoride and styrene-butadiene rubber.

19. The cathode of Claim 16, further including at least one of carbon black and graphite.

20. A composition, formed by a method comprising the steps:

a) combining lithium, nickel, cobalt, at least one element A selected from

EXPRESS MAIL NO. EV 327 868 705

the group consisting of barium, magnesium, calcium and strontium, and at least one element B selected from the group consisting of boron, aluminum, gallium, manganese, titanium, vanadium and zirconium, in the presence of oxygen, in a relative ratio of $Li_{x1}:A_{x2}:Ni_{1-y-z}:Co_y:B_z$,

wherein: x1 is greater than about 0.1 and equal to or less than about 1.3,

x2 is greater than about 0.0 and equal to or less than about 0.2, and

y is greater than about 0.0 equal to or less than about 0.2,

z is greater than about 0.0 and equal to or less than about 0.2; and

b) heating the combination to a crystallization temperature in a range of between about 400°C and about 950°C for a period of time that causes the elements to form a crystal structure.

20170209;20170216